

AD-781 672

USING THE METHOD OF LIGHT SCATTERING
IN STUDYING BIOLOGICAL AEROSOL

S. F. Fedyaev, et al

Foreign Technology Division
Wright-Patterson Air Force Base, Ohio

24 June 1974

AD 781 672

DISTRIBUTED BY:



National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

UNCLASSIFIED
Security Classification

AD-781672

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)

Foreign Technology Division
Air Force Systems Command
U. S. Air Force

2a. REPORT SECURITY CLASSIFICATION

UNCLASSIFIED

2b. GROUP

3. REPORT TITLE

USING THE METHOD OF LIGHT SCATTERING IN STUDYING BIOLOGICAL AEROSOL

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Translation

5. AUTHOR(S) (First name, middle initial, last name)

S. F. Fedyayev and V. A. Belyakov

6. REPORT DATE

1970

7a. TOTAL NO. OF PAGES

9

7b. NO. OF REPS

2

8a. CONTRACT OR GRANT NO.

8b. ORIGINATOR'S REPORT NUMBER(S)

9. PROJECT NO.

FTD-HT-23-1648-74

c.

d. T74-04-01

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

Foreign Technology Division
Wright-Patterson AFB, Ohio

13. ABSTRACT

01

Reproduced for
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. Department of Commerce
Springfield, VA 22151

DD FORM 1 NOV 68 1473

UNCLASSIFIED

Security Classification

FTD-HT- 23-1648-74

EDITED TRANSLATION

FTD-HT-23-1648-74

24 June 1974

USING THE METHOD OF LIGHT SCATTERING IN
STUDYING BIOLOGICAL AEROSOL

By: S. F. Fedyayev and V. A. Belyakov

English pages: 5

Source: Laboratornoye Delo, Nr. 11,
November 1971, pp. 699-701

Country of Origin: USSR
Translated by: Dean F. W. Koolbeck
Requester: FTD/PDTR
Approved for public release;
distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

FTD-HT- . 23-1648-74

//

Date 24 Jun 1974

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	А а	А, a	Р р	Р р	R, r
Б б	Б б	Б, b	С с	С с	S, s
В в	В в	V, v	Т т	Т т	T, t
Г г	Г г	G, g	У у	У у	U, u
Д д	Д д	D, d	Ф ф	Ф ф	F, f
Е е	Е е	Ye, ye; E, e*	Х х	Х х	Kh, kh
Ж ж	Ж ж	Zh, zh	Ц ц	Ц ц	Ts, ts
З з	З з	Z, z	Ч ч	Ч ч	Ch, ch
И и	И и	I, i	Ш ш	Ш ш	Sh, sh
Я я	Я я	Y, y	Щ щ	Щ щ	Shch, shch
К к	К к	K, k	Ь ь	Ь ь	"
Л л	Л л	L, l	Ы ы	Ы ы	Y, y
М м	М м	M, m	Ь ь	Ь ь	'
Н н	Н н	N, n	Э э	Э э	E, e
О о	О о	O, o	Ю ю	Ю ю	Yu, yu
П п	П п	P, p	Я я	Я я	Ya, ya

* ye initially, after vowels, and after ѿ, ѿ; ё elsewhere.
When written as є in Russian, transliterate as yє or є.
The use of diacritical marks is preferred, but such marks
may be omitted when expediency dictates.

USING THE METHOD OF LIGHT SCATTERING IN STUDYING BIOLOGICAL AEROSOL

S. F. Fedyayev, V. A. Belyakov
Moscow Scientific Research Institute
of Vaccines and Serums im.
Mechnikova

Contemporary artificial biological aerosols used for immunization of humans and animals are distinguished by a broad range of concentration of particles per unit volume and also by their polydispersed nature (from a fraction of a micron to tens of microns). Under these conditions instruments developed earlier for studying aerosol parameters and operating on the light-scattering principle turn out to be unsuitable.

Our basic task consisted in creating a method and an instrument which would insure sufficient accuracy in determining particulate and weight concentrations and also the spectrum of fractionation of vaccines administered as aerosols by means of atomizers.

It was necessary to create an instrument with high resolution - i.e., one which would insure 1) recording of particles ranging from 0.5 to 40 μm in size, 2) the possibility of measuring aerosol concentration to 500,000 particles per liter, and 3) simultaneous recording of the entire spectrum of particles.

Of the [available] photoelectronic instruments for recording particles in air we found it possible to use the electron-optical system of the AZ-4 instrument and to use it as the basis for the sensor of the installation being developed. The optical schematic of the sensor of the photoelectronic aerosol dispersiometer AD-1 is shown on figure 1.

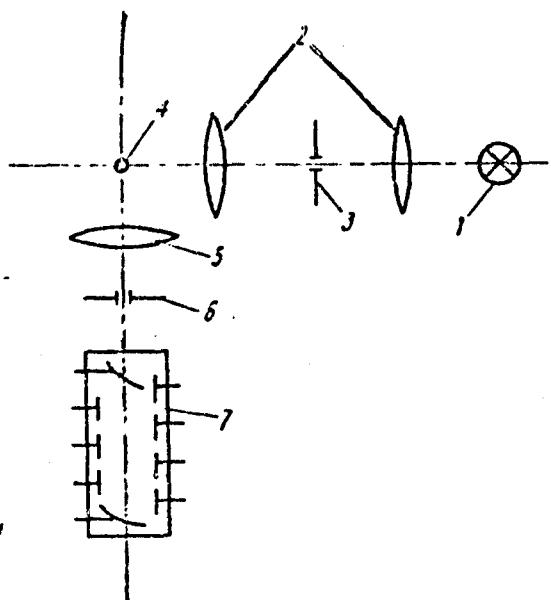


Figure 1. Optical schematic of the sensor. 1 - illuminator; 2 - illuminator objectives; 3 - illuminator diaphragm; 4 - feed line; 5 - PEM objective; 6 - PEM diaphragm; 7 - PEM.

A beam of light from illuminator (1) is shaped into a cylindrical beam with a diameter of 1 mm by means of diaphragm (3) and objectives (2). A flow of aerosol 1 mm in diameter is directed through sleeve 4, perpendicularly to the beam of light which is formed. The intersection of the light beam from the illuminator and the flow of aerosol forms the counting volume of the optical system of the sensor. The visual axis of the photoelectronic multiplier (PEM) is formed perpendicular to the plane of the beam of the illuminator and the flow of aerosol, intersecting the counting volume.

When particles in air enter the counting volume of the sensor they scatter the light from the illuminator, which is collected by

the PEM. As a result of this electrical impulses proportional to the square of the radius of the particles appear on the PEM output. After appropriate amplification the electrical pulses proceed from the sensor over a 5-meter cable to an amplitude selector in the analysis-counting unit. After distribution by fractions the pulses are counted and proceed to the indicator device - an electromechanical counter of the MES-54 type.

The AD-1 installation permits simultaneous recording of pulses in a broad range of particle sizes - diameter from 0.5 to 4 μm and from 3 to 40 μm . This is achieved because the installation contains two subranges with an automatic change in the gain factor of the pulse amplifier and automatic tuning of the amplitude selectors. The installation has five channels with different counting coefficients: 128, 64, 32, 16, and 8, respectively. The aerosol is passed through the sensor at a rate of 0.2 l/min. All of this makes it possible to monitor adequately concentrated artificial polydispersed biological aerosols (200,000-400,000 particles per liter).

The maximum particle counting concentration A is determined by the illuminated volume of aerosol flow in the sensor. On the basis of the Poisson distribution two and more particles will enter the illuminated volume of the aerosol with a probability of no more than 5% if the average number in the volume does not exceed 0.4 particles. Taking the diameter of the aerosol jet as $d=0.1$ cm and the width of the light beam which the particles intersect as $h=0.1$ cm, we find

$$A = \frac{4 \cdot 0.4}{\pi d^2 h} = 500 \text{ particles/cm}^3.$$

The instrument is calibrated against a relative monodispersed preparation - Lycopodium, 80% of whose spores have a diameter of 28 μm , which permits evaluating the magnitude of aerosol particles with sufficient accuracy.

The calibration procedure is as follows. An electron-optical sensor is installed with the collector pipe downward. A pump is connected on the opposite side and air is pumped through the illuminated volume of the sensor at a rate of 0.2 l/min. Gently shaking out a small quantity of Lycopodium in front of the collector fitting creates an aerosol cloud which is picked up by the air flow so that the Lycopodium particles enter the counting volume of the sensor, where the light which they scatter is converted into electrical impulses recorded on an oscilloscope. By determining the amplitude of the electrical pulse corresponding to a particle with average size of 28 μm and by considering the relationship of the pulse amplitude to be proportional to the square of the particle radius [1], it is possible to construct graph for tuning the amplitude selectors of the instrument (figure 2). After this, using a pulse generator, the triggering threshold of the selectors of all five channels are tuned on two subranges.

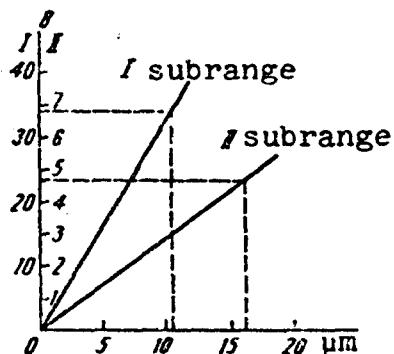


Figure 2. Graph for tuning the triggering thresholds of the instrument amplitude selectors. Abscissa - square of particle radius (in μm^2); ordinate - pulse amplitude (in V).

In order to compare the accuracy of calibration described above a more laborious calibration was carried out on a sedimentometer with an oil fog obtained by bubbling. No significant deviations were detected.

Experimental tests were carried out with chambers of different volumes: 0.7, 5.6, and 112 m^3 . Several dry aerosol vaccines from the Moscow Scientific Research Institute of Vaccines and Serums im. I. I. Mechnikova were used in the experiments. Vaccines were

atomized with a PAV-65 instrument. Pumping of air through the counting volume of the sensor was established at a rate of 0.2 l/min and was measured with a glass flow meter with a calibrated scale up to 1 l/min from a type 822 aspirator. Sampling sessions in the experiments were 15 minutes long. The collecting filter of the sensor was located horizontally. The weight concentration was monitored in parallel by two methods: protein content (Lowry method) and by the fluorescence of the test solution of vaccines (electronic fluorometer EF-3M). These samples were taken with an impinger.

Spectra of the counting and weight distributions of dry aerosol vaccines were obtained on the basis of numerous experiments.

Fractionation of dry vaccines by the PAV-65 instrument was subject to an exponential law, while the maximum weight concentration was found to be of particles 19 μm in diameter. This creates favorable conditions for vaccination - low reactogenicity with good immunogenic effect.

Thus, in our view, the photoelectronic method for studying particles of polydispersed biological aerosol vaccines in a flow of air is the only sufficiently reliable method for studying the spectrum of aerosol particle sizes, permitting analysis of the number and size of particles per unit volume and also observation of the kinetics of the changes in particle concentration in the course of the experiment [2].

BIBLIOGRAPHY

1. Лактионов А. Г. Изв. АН СССР. Серия геофиз.,
1959, № 11, с. 1658. — 2. Ефремова В. Н., Федяев С. Ф. Иммунитет и анатоксия у животных, вакцинированных аэрозолем столбнячного анатоксина различного фракционно-дисперсионного состава. Материалы Всес. межнагр. конференции, посв. 125-летию И. И. Мечникова «Иммунологическая реактивность организма при введении бактериальных препаратов». М., 1970, с. 128.

Received
25 June 1970

Aerosols, Study of